Stochastics of radiation measurement

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We consider radiation measurement, i.e., radiation emission and detection. In time T set p to be the probability to detect an emitted particle. $q = 1 - p$ is the probability not to be detected.

Suppose, we have in empty space a point source of N nuclides and the ideal (4π) detector. Let $r \,\epsilon\, [0, N]$ is the stochastic variable for the number of particles detected in the time T. r has the binomial distribution and the probability

$$p_m = \left(\begin{array}{c} N \\ r \end{array} \right) p^r q^{N-r}.$$

This subject you can find in references [1,2,3].

Radiation detection: When the particle or photon is emitted from the point source it has a solid angel Ω to go into the detector or it goes past that. The ratio $\Omega/4\pi$ multiplyed by the probability, that it is monitored in the detector, is here denoted by p_d.

Radiation emission: We know that in the time T $n = N(1 - \exp(-\lambda T))$ is the number of emitted particles (incl. photons). In [3] I suppose $p = 1 - \exp(-\lambda T)$ for the emission of a particle. Then

$$p_e = \left(\begin{array}{c} N \\ r \end{array} \right) (1 - \exp(-\lambda T))^r (\exp(-\lambda T))^{N-r}.$$

In the special case $T \ll t_{1/2}$ $\quad p_e$ has the Poisson distribution. $\lambda = ln(2)/t_{1/2}$. Always the error $\Delta n = \sigma(r) = \sqrt{n}\exp(-\lambda T/2)$.

Is $p_m = p_e\, p_d$ even for short lived radiation?

References
[1] L.J. Rainwater and C.S. Wu, Nucleonics **1** (1947), October, 60-69.
[2] V.I Gol'danskii, A.V. Kutsenko, and M.I. Podgoretskii, in Russian: Statistika otschetov pri registpatsiji jadernih tchastits, M.: Fizmatgiz, 1959.
[3] S. Kasi, Journal of Physical Science and Application **4**(3) (2014) 193-197.